



AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

- 1 1. (Currently amended) A method for communicating between a first
2 semiconductor die and a second semiconductor die through optical signaling,
3 comprising:
 - 4 converting an electrical signal into an optical signal using an electrical-to-
 - 5 optical transducer located on a face of the first semiconductor die;
 - 6 passing the optical signal through an interposer sandwiched between the
7 first semiconductor die and the second semiconductor die, wherein the interposer
8 contains a plurality of waveguides that direct the optical signal, so that the optical
9 signal shines on the second semiconductor die, and wherein the plurality of
10 waveguides have a pitch less than 50 microns;
 - 11 wherein the first semiconductor die and the second semiconductor die are
12 oriented face-to-face so that the optical signal generated on the first
13 semiconductor die shines on the second semiconductor die;
 - 14 receiving the optical signal on a face of the second semiconductor die; and
15 converting the optical signal into a corresponding electrical signal using an
16 optical-to-electrical transducer located on the face of the second semiconductor
17 die.
- 1 2. (Original) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises passing the

3 optical signal through annuli located within metal layers on the first
4 semiconductor die to focus the optical signal onto the second semiconductor die.

1 3. (Original) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises using a lens to
3 focus the optical signal onto the second semiconductor die.

1 4. (Original) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises using a mirror
3 to reflect the optical signal, so that the optical signal can shine on the second
4 semiconductor die without the first semiconductor die having to be coplanar with
5 the second semiconductor die.

1 5 (Canceled).

1 6. (Original) The method of claim 1,
2 wherein the electrical-to-optical transducer is a member of a plurality of
3 electrical-to-optical transducers located on the first semiconductor die; and
4 wherein the optical-to-electrical transducer is a member of a plurality of
5 optical-to-electrical transducers located on the first semiconductor die;
6 whereby a plurality of optical signals can be transmitted in parallel from
7 the first semiconductor die to the second semiconductor die.

1 7. (Original) The method of claim 6,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and

4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 8. (Original) The method of claim 6,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 9. (Original) The method of claim 1, wherein the electrical-to-optical
2 transducer includes one of:
3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 10. (Original) The method of claim 1, wherein the optical-to-optical
2 transducer includes one of:
3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.

1 11. (Currently amended) An apparatus for communicating between
2 semiconductor chips through optical signaling, comprising:
3 a first semiconductor die;
4 a second semiconductor die;

5 an electrical-to-optical transducer located on a face of the first
6 semiconductor die, which is configured to convert an electrical signal into an
7 optical signal;

8 wherein the first semiconductor die and the second semiconductor die are
9 oriented face-to-face so that the optical signal generated on the first
10 semiconductor die shines on the second semiconductor die;

11 an optical-to-electrical transducer located on a face of the second
12 semiconductor die, which is configured to convert the optical signal received from
13 the first semiconductor die into a corresponding electrical signal; and

14 an interposer sandwiched between the first semiconductor die and the
15 second semiconductor die, wherein the interposer contains a plurality of
16 waveguides that direct the optical signal, so that the optical signal shines on the
17 second semiconductor die, and wherein the plurality of waveguides have a pitch
18 less than 50 microns.

1 12. (Original) The apparatus of claim 11, further comprising annuli located
2 within metal layers on the first semiconductor die configured to focus the optical
3 signal onto the second semiconductor die.

1 13. (Original) The apparatus of claim 11, further comprising a lens
2 configured to focus the optical signal onto the second semiconductor die.

1 14. (Original) The apparatus of claim 11, further comprising a mirror
2 configured to reflect the optical signal, so that the optical signal can shine on the
3 second semiconductor die without the first semiconductor die having to be
4 coplanar with the second semiconductor die.

1 15 (Canceled).

1 16. (Original) The apparatus of claim 11,
2 wherein the electrical-to-optical transducer is a member of a plurality of
3 electrical-to-optical transducers located on the first semiconductor die; and
4 wherein the optical-to-electrical transducer is a member of a plurality of
5 optical-to-electrical transducers located on the first semiconductor die;
6 whereby a plurality of optical signals can be transmitted in parallel from
7 the first semiconductor die to the second semiconductor die.

1 17. (Original) The apparatus of claim 16,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and
4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 18. (Original) The apparatus of claim 16,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 19. (Original) The apparatus of claim 11, wherein the electrical-to-optical
2 transducer includes one of:
3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 20. (Original) The apparatus of claim 11, wherein the optical-to-optical
2 transducer includes one of:
3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.

1 21. (Currently amended) A computer system including semiconductor
2 chips that communicate with each other through optical signaling, comprising:
3 a first semiconductor die containing one or more processors;
4 a second semiconductor die containing circuitry that communicates with
5 the one or more processors;
6 an electrical-to-optical transducer located on a face of the first
7 semiconductor die, which is configured to convert an electrical signal into an
8 optical signal;
9 wherein the first semiconductor die and the second semiconductor die are
10 oriented face-to-face so that the optical signal generated on the first
11 semiconductor die shines on the second semiconductor die;
12 an optical-to-electrical transducer located on a face of the second
13 semiconductor die, which is configured to convert the optical signal received from
14 the first semiconductor die into a corresponding electrical signal; and
15 an interposer sandwiched between the first semiconductor die and the
16 second semiconductor die, wherein the interposer contains a plurality of
17 waveguides that direct the optical signal, so that the optical signal shines on the
18 second semiconductor die, and wherein the plurality of waveguides have a pitch
19 less than 50 microns.

1 22. (Original) The computer system of claim 21, further comprising annuli
2 located within metal layers on the first semiconductor die configured to focus the
3 optical signal onto the second semiconductor die.

1 23. (Original) The computer system of claim 21, further comprising a lens
2 configured to focus the optical signal onto the second semiconductor die.

1 24. (Original) The computer system of claim 21, further comprising a
2 mirror configured to reflect the optical signal, so that the optical signal can shine
3 on the second semiconductor die without the first semiconductor die having to be
4 coplanar with the second semiconductor die.

1 25 (Canceled).

1 26. (Original) The computer system of claim 21,
2 wherein the electrical-to-optical transducer is a member of a plurality of
3 electrical-to-optical transducers located on the first semiconductor die; and
4 wherein the optical-to-electrical transducer is a member of a plurality of
5 optical-to-electrical transducers located on the first semiconductor die;
6 whereby a plurality of optical signals can be transmitted in parallel from
7 the first semiconductor die to the second semiconductor die.

1 27. (Original) The computer system of claim 26,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and
4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 28. (Original) The computer system of claim 26,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and

4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 29. (Original) The computer system of claim 21, wherein the electrical-to-
2 optical transducer includes one of:

3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 30. (Original) The computer system of claim 21, wherein the optical-to-
2 optical transducer includes one of:

3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.